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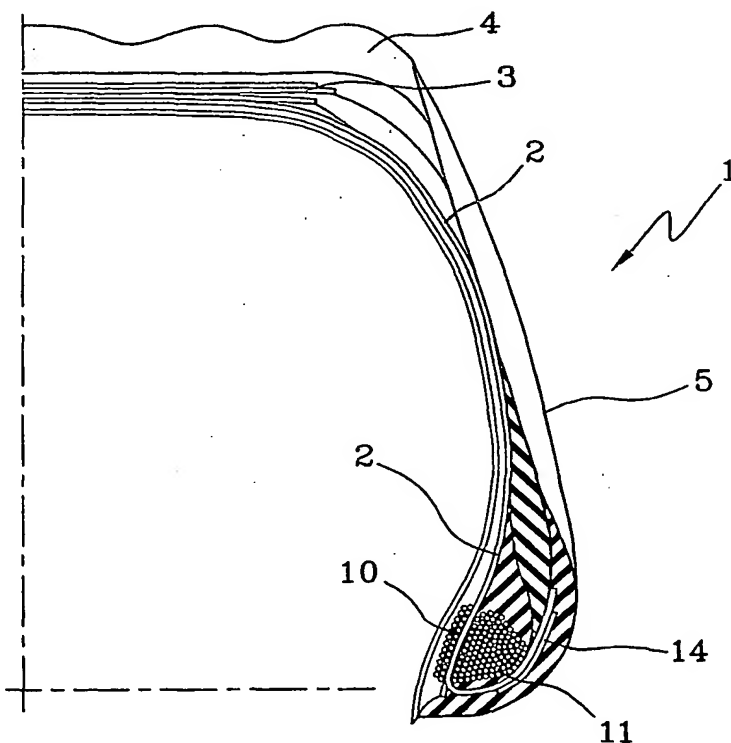
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(54) Title: TYRE FOR VEHICLE WHEELS AND METHOD OF MANUFACTURING



(57) Abstract: A tyre for vehicle wheels comprising a carcass structure including at least one carcass ply (2), at least one annular reinforcing structure associated with said carcass structure, one tread band (4) at a radially external position to said carcass structure, and a pair of sidewalls (5) at axially opposite positions on said carcass structure, each carcass ply (2) comprising a plurality of elongated elements, said elements being disposed in a substantially U-shaped conformation around the cross-section profile of said tyre (1), said carcass structure having two side portions at positions spaced apart from each other in an axial direction, and a crown portion extending at a radially external position between said side portions, wherein only a number of the plurality of said elongated elements is turned-up around said at least one annular reinforcing structure.

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- 1 -

## TYRE FOR VEHICLE WHEELS AND METHOD OF MANUFACTURING

Description

5 The present invention relates to a tyre for vehicle wheels and to a method of manufacturing it.

A tyre for vehicle wheels usually comprises a carcass structure essentially consisting of one or more carcass  
10 plies shaped in a substantially toroidal conformation and having their axially opposite side edges in engagement with respective annular reinforcing structures, each comprising at least one bead core, each ply having a plurality of cords parallel to each  
15 other incorporated into at least one layer of elastomer material. Each annular reinforcing structure is incorporated in a so-called "bead" defined along an inner circumferential edge of the tyre for tyre anchoring to a corresponding mounting rim.

20 In the so-called "radial" tyres each of the cords arranged in the carcass ply or plies lies in a plane substantially radial to the tyre rotation axis, i.e. each cord has an orientation substantially orthogonal  
25 to the circumferential extension direction.

In this case a belt structure is generally applied to the carcass structure, at a radially external position, which belt structure comprises one or more belt strips  
30 shaped like a closed ring and essentially consisting of textile or metallic cords incorporated in a layer of elastomer material, parallel to each other and suitably oriented relative to the cords belonging to the adjacent carcass plies and/or belt strips.

35

PT0276

- 2 -

Coaxially arranged at a radially external position to the belt structure is a tread band intended for rolling contact of the tyre on the ground and usually provided with a raised pattern defined by cuts and grooves  
5 formed in the band thickness which are adapted to ensure the necessary grip qualities of the tyre on the ground.

It is to be pointed out, to the aims of the present  
10 invention, that by the term "elastomer material" it is intended a composition comprising at least one elastomer polymer and at least one reinforcing filler and possibly additives of different types (cross-linking agents, plasticizers and other additives known  
15 in the art, for example).

Provided on the opposite sides of the tyre is a pair of sidewalls each of which covers a side portion of the tyre included between a so-called shoulder region  
20 located close to the corresponding side edge of the tread band, and the corresponding bead.

In the traditional manufacturing processes, formation of each carcass ply is carried out by making a  
25 rubberised fabric comprising a plurality of reinforcing thread-like elements, incorporated in a layer of elastomer material, parallel to each other, in the following referred to as "cords"; this term is used to define both individual strands (monofilaments, flosses,  
30 yarns, wires) and true cords, i.e. a structure comprising one or more strands twisted together, each consisting of a given number of elementary filaments twisted with each other. Said rubberised fabric is made through a calendering operation for example, in which a  
35 plurality of said cords disposed in coplanar side by

PT0276

- 3 -

side relationship with each other are sandwiched between two layers of elastomer material. The threads of said cords may consist of metal alloys such as steel, textile fibres, carbon fibres, glass fibres, 5 Kevlar® or other fibres having an appropriate resistance for use in making tyres.

Each carcass ply is then assembled with the other tyre components, such as said bead cores for example, on a 10 so-called cylindrical building drum. The carcass ply is turned up around said bead cores in such a manner that when the whole carcass structure, first made in the form of a cylindrical sleeve, is shaped into a toroidal conformation, the carcass ply and bead cores keep 15 associated with each other, the carcass ply being turned up around said bead cores and extending from the inside to the outside both axially and radially.

In a subsequent operation other tyre components, such 20 as belt structure, sidewalls and tread band, are then assembled (on a shaping drum for example) on said carcass structure.

According to recent production processes, as depicted 25 in document EP 928 680 for example, in the name of the same Applicant, a tyre can be directly built on a toroidal support. A first carcass ply is formed by laying strip-like elements on said toroidal support, each of said strip-like elements comprising 30 longitudinal thread-like elements incorporated in a layer of elastomer material. Said strip-like elements are sequentially laid down so as to form a carcass structure in which the strip-like elements are partly overlapped at side portions of the tyre and disposed in 35 circumferential side by side relationship with each

PT0276

- 4 -

other at the crown region of the tyre itself. Annular reinforcing structures are associated with the carcass ply which comprise a first and a second circumferential annular inserts for example, and an elastomer filler interposed therebetween. A second carcass ply can be made in superposed position with respect to the first carcass ply and said annular structures. Then a belt structure also made by deposition of strip-like elements is associated with the carcass structure thus formed. Subsequently, a tread band and a pair of sidewalls are applied by superposition of an elementary semi-finished product of elastomer material in the form of a strap of appropriate sizes laid down into coils disposed in axial side by side and/or radial superposition relationship. Therefore, this process contemplates use of at least two different types of elementary semi-finished products and more specifically a strap, i.e. a section member made of elastomer material alone of substantially rectangular section and the strip-like element of elastomer material into which thread-like reinforcing elements are incorporated, typically textile or metallic cords. The strip-like element thus made contains a given number of cords per centimetre of its transverse dimension, and said number identifies the "density" of the cords.

It should be noticed that the tyre made in accordance with the above description has its carcass structure associated with the annular reinforcing structures but not turned up with respect to the latter. To comply with the requirements of a carcass structure more linked to the annular reinforcing structures and obviate possible structural problems arising from the carcass ply partly slipping off the annular reinforcing structures during tyre manufacture, some solutions have

PT0276

- 5 -

been proposed.

For example, document EP 0 983 876 discloses a radial tyre in which the carcass ply is formed of a continuous  
5 cord repeating in succession a path between a pair of bead portions in a direction circumferential to the tyre.

Document WO 00/26043 in the name of the same Applicant  
10 discloses a tyre and a method of making it, in which the carcass structure comprises at least one carcass ply formed of strip-like elements comprising longitudinal thread-like elements incorporated in a layer of elastomer material. The strip-like elements  
15 have respective crown portions disposed in circumferential side by side relationship with each other, as well as side portions radially extending at the tyre sidewalls. The side portions are each at least partly covered with a side portion belonging to a  
20 stretch of an adjacent portion. Associated with the carcass ply are annular structures each of which comprises a pair of inextensible inserts having the conformation of an annulus, between which a turned-up flap of the carcass ply is interposed, after possible  
25 interposition of an elastomer filling insert.

The Applicant has ascertained that a tyre built in accordance with the above mentioned documents can have some drawbacks. In particular, the Applicant could  
30 notice that the diameter in the crown region of the toroidal support on which building takes place, is bigger than the diameter at the beads and this condition is more marked in the toroidal supports designed for making tyres for heavy-duty vehicles such  
35 as trucks, articulated lorries and the like.

PT0276

- 6 -

Consequently, deposition of a plurality of elongated elements circumferentially adjacent to each other in the crown region of the carcass causes overlapping of the ends of said elements in the bead region. This  
5 circumstance brings to construction of beads having an apparently reinforced structure due to the increased density of the cords, which structure is on the contrary substantially weakened. In fact, under use conditions the mutually superposed cords do not work  
10 correctly and in a uniform manner, some of them being strongly submitted to tensile stresses, other to compressive stresses, thereby triggering separation between the elastomer material and the reinforcing cords so that, as a result, the tyre will have a  
15 shorter duration.

The Applicant has also ascertained that turning up such a structure, i.e. a carcass ply obtained by approaching and/or partially overlapping a plurality of elongated  
20 elements around an annular reinforcing structure, generates a further increase in the structural unevenness in a critical tyre region such as the bead region, which unevenness too has then repercussions on the tyre duration as it generates irregularities in  
25 stress distribution during rolling and possible fatigue failure in relatively short periods of time.

The Applicant has found that a tyre built on a toroidal support has a more regular structure which is  
30 consequently more effective in stress distribution if at least one carcass ply associated with an annular reinforcing structure is only partly turned up around a bead core belonging to said structure.

35 More specifically, the Applicant has found that the

PT0276

- 7 -

drawbacks found in the known art can be overcome by turning up only part of the elongated elements laid on said toroidal support, preferably those that are not mutually adjacent.

5

It is to be pointed out that an elongated element is intended here and in the following as "turned up" around an annular reinforcing structure or a bead core in the bead region, if at least one straight line  
10 parallel to the straight line tangent to the radially outermost point of the tyre section identified by the lying plane of said elongated element crosses the profile of said elongated element in said bead region at least at two distinct points. In the case of a  
15 radial tyre, the lying plane of said elongated element is substantially coincident with a right section of the tyre and the straight line tangent to the radially outermost point of said right section is parallel to the rotation axis of the tyre itself.

20

By "bead region" it is intended, as previously illustrated, the axially internal circumferential region of the tyre designed for tyre anchoring to a mounting rim, each bead region internally comprising  
25 said annular reinforcing structure.

More particularly, the Applicant has found that in a tyre built on a toroidal support, having at least one carcass ply comprising a plurality of elongated  
30 elements laid on said toroidal support in such a manner that at least part of said elongated elements has an end radially internal to the ends of the adjacent elongated elements, turning-up of said ends around an annular reinforcing structure prevents occurrence of  
35 superpositions in said ply, between the cords of

PT0276

- 8 -

adjacent elongated elements and between the elongated elements themselves at their end portions. In this way the Applicant obtains a tyre having a mechanically homogeneous structure at the bead region due to the presence of a carcass ply partly turned up around at least one bead core belonging to an annular reinforcing structure.

In a first aspect the invention relates to a tyre for vehicle wheels comprising: a carcass structure including at least one carcass ply, said carcass structure having two side portions at positions spaced apart from each other in an axial direction, and a crown portion extending in a radially external position between said side portions, at least one annular reinforcing structure associated with said carcass structure at said side portions, said annular reinforcing structure comprising at least one bead core, one tread band at a position radially external to said carcass structure, and a pair of sidewalls at axially opposite positions on said carcass structure, each carcass ply comprising a plurality of elongated elements disposed in a substantially U-shaped conformation around the cross-section profile of said tyre, wherein a fraction of the plurality of said elongated elements is turned up around said at least one bead core.

In a preferred embodiment, said annular reinforcing structure comprises a first bead core at an axially internal position and a second bead core at an axially external position relative to said carcass ply.

In a different embodiment, said fraction of the plurality of elongated elements is turned up around

PT0276

- 9 -

said axially-external second bead core.

In another embodiment, said fraction of the plurality of elongated elements is turned up around said axially-  
5 internal first bead core.

In a particular embodiment, in the tyre in accordance with the invention said elongated elements are provided to consist of strip-like elements.

10

In a preferred embodiment, said strip-like elements are of at least two lengths different from each other.

In a further embodiment said strip-like elements are of  
15 the same length.

In a further aspect the invention relates to a method of manufacturing a tyre for vehicle wheels, said tyre comprising a carcass structure including at least one  
20 carcass ply, at least one annular reinforcing structure comprising at least one bead ring and associated with said carcass structure, one tread band at a radially external position to said carcass structure, and a pair of sidewalls at axially opposite positions on said  
25 carcass structure, wherein accomplishment of said carcass structure comprises the steps of:

- preparing a plurality of elongated elements coated with at least one layer of elastomer material;
- laying each elongated element onto a toroidal support  
30 in a substantially U-shaped conformation around the cross-section profile of said toroidal support to define two side portions spaced apart from each other in an axial direction, and a crown portion extending at a radially external position between said side  
35 portions;

PT0276

- 10 -

- applying said at least one bead core at a region close to said side portions, at least one fraction of said elongated elements having an end at a radially more internal position than said at least one bead core;
- turning up said ends of said fraction around said bead core.

In a preferred embodiment, said turning-up step is preceded by a step of laying at least one axially-internal first bead core and one axially-external second bead core relative to said carcass ply.

In a further embodiment said turning-up step is carried out around said axially-external second bead core.

In a different embodiment of the method in accordance with the invention, said turning up step is carried out around said axially-internal first bead core.

Further features and advantages of the invention will become more apparent from the detailed description of some preferred but not exclusive embodiments of a tyre for vehicle wheels and the manufacturing method related thereto, in accordance with the present invention.

This description will be set out hereinafter with reference to the accompanying drawings given by way of non-limiting example, in which:

- Fig. 1 is a diagrammatic view in right section of a green tyre built by the method of the invention;
- Fig. 1b is a partial perspective view of the tyre in reference during building of same;
- Fig. 2 is a development in a horizontal plane of an embodiment of a carcass ply of the tyre in accordance

PT0276

- 11 -

with the invention;

- Fig. 3 is a development in a horizontal plane of a further embodiment of a carcass ply of the tyre in accordance with the invention;

5 - Fig. 4a is an extension in a horizontal plane of another embodiment of a carcass ply of the tyre of the invention;

10 - Fig. 4b is a plan view of two different strip-like elements forming the ply in Fig. 4a submitted to a necking-down step;

- Fig. 5a is a development in a horizontal plane of a different embodiment of a carcass ply of the tyre in accordance with the invention;

15 - Fig. 5b is a plan view of two different strip-like elements (one of them in two distinct positions) forming the ply in Fig. 5a submitted to a necking-down step;

- Fig. 6 is a view in right section of the bead region of the tyre obtained by the method in reference;

20 - Fig. 7 is a view in right section of the bead region of a different embodiment of the tyre obtained by the method in reference;

25 - Fig. 8 is a view in right section of the bead region of a further embodiment of the tyre obtained by the method in reference;

- Fig. 9 is a partial perspective view of the bead of the tyre in reference during manufacture of same;

30 - Fig. 10 is a partial perspective view of the bead of the tyre in reference in which an alternative embodiment of the method of the invention has been adopted;

- Fig. 11 is a view in right section of the bead region shown in Fig. 10;

35 - Fig. 12 is a view in right section of the bead region of a different embodiment of the tyre of the invention.

PT0276

- 12 -

With reference to Fig. 1, a tyre for vehicle wheels made by the method of the invention is identified by reference numeral 1.

5

Tyre 1 essentially comprises a carcass structure having at least one carcass ply 2 of a toroidal conformation, which is associated by its circumferential edges with a pair of annular reinforcing structures, each having at least one bead core and each of which, in the finished tyre, is positioned in a region usually defined as "bead" which ensures coupling of the tyre with the tyre mounting rim. At a radially external position to said carcass ply 2 a belt structure 3 is provided which comprises one or more belt strips superposed on each other. A tread band 4 is disposed thereupon at a radially external position to said belt structure: in the vulcanised tyre, this band usually has an appropriate tread pattern (not shown) moulded during the vulcanisation process; finally a pair of sidewalls 5 is laterally provided on opposite sides of said carcass structure.

The carcass structure is internally preferably coated with a layer of elastomer material defined as "liner" to ensure air-tightness of the tyre under use conditions.

Assembling of the above listed parts is carried out as substantially illustrated in the already mentioned document EP 0 928 680 in the name of the same Applicant. In short, a limited number of semi-finished products such as straps of elastomer material, elongated elements i.e. strip-like elements of elastomer material reinforced with textile or metallic

PT0276

- 13 -

5 cords, and wires, generally steel wires, also coated with elastomer material, are fed onto a toroidal support having the same configuration as the inner walls of the tyre that is wished to be obtained. Said support is set in motion, preferably by a robotized system, through a plurality of stations in each of which a particular one of the tyre building steps is carried out by means of automated sequences. Thus the whole tyre 1 structure described above is formed by superposition on said toroidal support, thereby obtaining a green tyre ready for vulcanisation.

15 More specifically, in accordance with the invention, on a toroidal support the outer profile of which matches that of the radially inner surface of the green tyre, at the beginning of the building process the so-called "liner" is preferably laid, said liner substantially consisting of a rubber sheet that in the vulcanised tyre constitutes the inner surface of the tyre itself, which is air-proof.

Before making the carcass ply, one or more elastomer fillers (not shown) are optionally laid on said toroidal support, which fillers preferably have a shape radially tapering outwardly in a right-section view of the tyre.

Manufacture of said tyre 1 goes on by laying, on said toroidal support, a first pair of bead cores 10 each belonging to a different one of said annular reinforcing structures, at a position radially internal and/or axially external to said elastomer filler.

More particularly, each bead core 10 comprises a pack of coils made of thread (preferably wire) disposed in

PT0276

- 14 -

radial superposition and axial side by side relationship with each other.

To build the coil pack, a plurality of coils is wound  
5 on said building support, said coils being radially superposed upon themselves and in axial side by side relationship and consisting of a metal wire or, alternatively, of a cord of metal wires, a ribbon of said wires or cords, or also a metal strap.

10

Alternatively, each coil pack can be made separately and subsequently applied on said toroidal support.

The material used for said bead cores can be any  
15 textile or metallic material or a material of other nature provided with appropriate features of mechanical strength; preferably this material is a steel wire commonly utilised in the tyre technology, or a metallic cord provided with a corresponding strength and load  
20 ability.

Subsequently to laying of said bead cores 10, laying of one or more carcass plies 2 begins, so as to make the carcass structure of the tyre of the invention.

25

The following description refers, without any limiting purpose, to building of a tyre for heavy-duty vehicles such as trucks, articulated lorries, buses and the like, and therefore manufacture and use of strip-like  
30 elements of elastomer material reinforced with metallic cords is advantageously provided for said carcass ply. In the case of tyres of other type (for cars, for example) the reinforcing cords of said strip-like element are preferably textile cords of natural or  
35 synthetic fibre (cotton, polyamide, polyester),

PT0276

- 15 -

typically nylon or rayon.

Said elongated element or strip-like element is prepared by use of preferably 2 to 6 metallic cords conducted through an extrusion head coating them with a suitable elastomer material, thereby creating a continuous ribbon-like element in which said cords are parallel to each other in the longitudinal direction of the element itself.

10

The diameter of the metal wire used for making said cords can be included between 0.12 and 0.4 mm, preferably between 0.14 and 0.23 mm, whereas said cords are preferably made with a wrapped structure, in the following configurations, for example: 3+9x0.22W and 3+9+15x0.175W. Use of a cord having a 7x4x0.175W configuration, i.e. comprising 7 strands, each consisting of 4 elementary steel filaments with a 0.175 mm diameter, wound by a wrapped wire consisting of a steel wire with a 0.15 mm diameter, spiralled around the cord, has been judged as particularly suitable.

20

The continuous ribbon-like element thus made is not directly employed but duly cut to size to form said strip-like elements, for application on said toroidal support to make said carcass ply 2.

25

In accordance with the disclosure of the patent application PCT/IT01/00656 in the name of the same Applicant, preferably each strip-like element previously to said application is submitted to a necking-down step at intervals, along its longitudinal extension, which locally modifies the cross-sectional profile thereof and the cord density.

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PT0276

- 16 -

More specifically, driving members not shown drag forward the end portion of said continuous ribbon-like element that has been submitted to necking-down and bring a subsequent portion to a necking-down position.

5 After this portion too has been submitted to a necking-down step, cutting members, not shown too, cut said ribbon-like element generating said strip-like element of the required size for use in the carcass structure of the tyre (Figs. 4b, 5b). Said strip-like element is

10 then picked up by gripping members (not shown) for making, as better illustrated in the following, said carcass ply 2, whereas the driving members bring another portion of the continuous ribbon-like element to a position adapted to submit it to a necking-down

15 step.

In accordance with the invention, during manufacture of said carcass ply 2, gripping members of the same type, for example, as described in the European Patent

20 Application issued under No. 0 928 680, dispose each strip-like element on said toroidal support in a substantially U-shaped conformation around the cross-section profile of said support to define two side portions substantially extending in planes orthogonal

25 to the geometric rotation axis of the support itself, at axially spaced apart positions, and a crown portion extending in a radially external position between said side portions.

30 More specifically, in the embodiment shown in Figs. 1b and 2 for example, the strip-like elements 6, 6' previously cut to two different lengths,  $L_1$  and  $L_2$  respectively, with  $L_1 > L_2$ , are disposed in a mutually-alternated side by side relationship at the end of the

35 manufacture of the carcass ply 2, all strip-like

PT0276

- 17 -

elements being laid down symmetrically with respect to the equatorial plane of the toroidal support, i.e. the transverse centre lines of each strip-like element 6, 6' are aligned with each other and they all substantially lie in said equatorial plane X-X.

Alternatively, as shown in Fig. 3, the strip-like elements 7, 7' are cut to a single length  $L_3$ , each strip-like element being disposed asymmetrically with respect to said equatorial plane X-X, at the end of the manufacture of the carcass ply. More exactly, the transverse centre lines of each strip-like element 7, aligned with each other, are not aligned, when deposition has been completed, with the transverse centre lines (which are aligned with each other too) of the strip-like elements 7', the lying planes of the transverse centre lines of the strip-like elements 7 and 7' being thus distinct from each other and offset on opposite sides with respect to the equatorial plane X-X.

As can be noticed, by these depositions the resulting carcass ply 2 just built on the toroidal support has a plurality of terminal parts or ends of the component strip-like elements at a radially more internal position on each side of the toroidal support than the immediately adjacent strip-like elements, said ends being separated by a gap "s".

Obviously, any combination of the above illustrated arrangements is in principle possible.

For example, as shown in Fig. 4a, by making use of the above mentioned strip-like elements 6 and 6' of length  $L_1$  and  $L_2$ , said strip-like elements can be such laid

PT0276

- 18 -

that on ply 2 a strip-like element of greater length  $L_1$  is obtained which is alternated with at least two strip-like elements of smaller length  $L_2$ , three strip-like elements in the case shown in said figure.

5 In another embodiment, the strip-like elements 7 and 7' of the same length  $L_3$  and asymmetrically laid as above illustrated, are alternated with at least one strip-like element 7" of smaller length  $L_4$  symmetrically laid with respect to the equatorial plane X-X, as shown for  
10 the strip-like elements 6 and 6'.

In this way the distance or gap "s" between two ends of two strip-like elements in succession having a greater radially internal extension than the ends of the strip-  
15 like elements interposed therebetween can be adjusted at will.

More particularly, the Applicant considers as the preferred ones those embodiments in which said carcass  
20 plies (made as in Figs. 2 and 3) have said distance "s" substantially coincident with the transverse size of the strip-like element end.

Preferably, the cords of each strip-like element are  
25 disposed radially, i.e. at  $90^\circ$  with respect to the circumferential direction of the toroidal support.

The strip-like elements 6, 6', 7, 7', 7" adhere to the underlying layers over the whole longitudinal extension  
30 thereof, going from bead to bead along the outer surface of the toroidal support, because the latter is preferably coated with an adhesive material, said liner for example.

35 As shown in Figs. 2, 3, 4a, 5a, said strip-like

PT0276

- 19 -

elements are disposed in side by side relationship along the circumferential extension of said toroidal support. As a result of necking-down exerted on the end regions of the strip-like element balancing the  
5 circumferential extension at the crown with the circumferential extension at the beads, said side by side arrangement is advantageously maintained along the whole linear extension, from bead to bead.

10 Said arrangement can be achieved either by a single rotation of the toroidal support, by virtue of a continuous approaching of each strip-like element with respect to the preceding one, in which case, when required, a cutting step is to be carried out for  
15 making strip-like elements of different length ( $L_1$ ,  $L_2$ ,  $L_3$  or  $L_4$ ), or preferably by two or more rotations of the same support. In the last mentioned case laying of each strip-like element 6, 6', 7, 7', 7" is followed by a rotation of the support corresponding to a multiple  
20 of the circumferential space occupied by each strip-like element, to enable laying of another series of strip-like elements during the subsequent turn, going on until the whole toroidal surface is completely covered: at this point the carcass ply 2 has been  
25 completed. In this case by an appropriate control of the laying step and the step of rotating the toroidal support it is possible to advantageously treat only groups of strip-like elements of the same length alternated with each other during laying.

30 Subsequently to the carcass ply 2, said annular reinforcing structures are completed by deposition of a further pair of bead cores 11 at a position axially external to said bead cores 10. Accomplishment of the  
35 bead cores 11 takes place following the same modalities

PT0276

- 20 -

as previously illustrated for deposition of the bead cores 10 and substantially using the same materials.

Preferably, the axial extension of the bead cores 11 is  
5 greater than the axial extension of the bead cores 10.

Once said bead cores 11 have been made, tyre 1 under building will have one carcass ply 2 sandwiched between the bead cores 10 and 11, with a plurality of said  
10 strip-like elements having at least one of their ends at a position radially internal to said bead cores 10, 11, i.e. projecting in a radially internal direction with respect to said bead cores.

15 Other strip-like elements will have both ends substantially enclosed by said bead cores, i.e. substantially not projecting therefrom in a radially internal direction; for example they can project in a direction radially internal to said bead cores 10, 11  
20 over a length generally not exceeding 2% of the transverse length from bead to bead of the carcass ply.

Said ends projecting in a radially internal direction from said bead cores 10, 11 are then turned up  
25 preferably around the axially external bead cores 11.

To carry out this step, an appropriate inflatable bladder (called "bladder turn up") can be employed, as well as other mechanical devices capable of lifting  
30 said ends bringing them into contact with the axially and radially external edges of the axially external bead cores 11 (Figs. 6, 9).

It will be recognised that the percentage of the strip-  
35 like elements that will have one of their ends turned

PT0276

- 21 -

up around the same annular reinforcing structure and in particular the same bead core can vary, depending on the deposition carried out for building said carcass ply 2. For example, in accordance with that which is shown in Figs. 2 and 3, said percentage is substantially 50%, and it is 25% in Figs. 4a and 5a. In any case the Applicant thinks it preferable to make the carcass ply in such a manner as to allow a percentage of strip like element ends turned up around each bead core that substantially does not exceed 50%, to advantageously avoid any possibility of overlapping of two adjacent strip-like elements that are to be turned up.

15 In an alternative embodiment shown in Fig. 12, said ends projecting in a radially internal direction from said bead cores 10, 11 are turned up partly around the axially external bead cores 11 and partly around the axially internal bead cores 10. It will be recognised that in this way, all of the elongated elements or strip-like elements forming the carcass ply can be altogether turned up around an annular reinforcing structure, for example by turning up 50% of them around the axially internal bead core and 50% around the axially external bead core. In this case, since substantially all the strip-like elements will have their ends projecting in a radially internal direction with respect to the bead cores 10, 11, it is required that necking down to which such elements are submitted as well as the sizes of said elements and/or the geometries at stake of the toroidal support should be of such a nature as to substantially avoid overlapping phenomena of the different elements at the bead region.

35 Preferably the interface stretch "c" between said

PT0276

- 22 -

carcass ply 2 and said bead cores 10, 11, measured along the cross sectional profile of said ply 2 is included between 15 and 70 mm (Fig. 6).

5 In a preferred embodiment of tyre 1, the step of turning up the ends is preceded by laying of a layer of reinforced polymeric material (with or without short fibres of the aramidic type, Kevlar® for example) which is located at a position axially external to the  
10 bead core 11 substantially in contact with the axially external edge of the latter, being consequently in a position axially internal to said turned-up end of the strip-like elements of said ply 2.

15 In a different embodiment of tyre 1 in accordance with the invention (Fig. 7), the annular reinforcing structures of said tyre are completed with a third pair of bead cores 12 at a position axially external to said bead cores 11 so as to enclose the end portions of the  
20 turned-up strip-like elements between the bead cores 11 and 12.

Said bead cores 12 consist of a stiffening element of the bead region acting against bending stresses, but  
25 they can also perform the structural function of protective edge, to protect the carcass ply 2 from the rim flange.

In a further alternative embodiment of the tyre in  
30 reference, as shown in Fig. 8, said bead cores 11 can be replaced by bead cores 13 called "of standard production", i.e. made separately as a semi-finished product and subsequently applied to said tyre 1 after making the carcass ply 2. In this case, to improve the  
35 interface between the bead cores 10, 13 and the carcass

PT0276

- 23 -

ply interposed therebetween, laying of some coils of spiralled bead core (i.e. coils similar to those of the bead core 10) may be suitable at an axially external position to said ply 2 and axially internal to said  
5 bead core 13 of standard production.

In another alternative embodiment of the tyre in reference, the turned-up portion of said strip like element ends can take place at different moments  
10 thereby obtaining strip like element ends turned up in different planes (Figs. 10, 11). In this case it is preferable for said turning-up step to be carried out in two sub-steps separated by a step of laying a filler in an axially external position to the axially external  
15 edge of said second bead core 11 or 13, the strip like element ends turned-up during the second sub-step lying consequently in different planes relative to the strip like element ends turned up during the first sub-step.

20 The resulting carcass ply therefore will have a plurality of elongated elements turned up in different planes around said annular reinforcing structures.

As shown for example in Figs. 1, 6, 8, 11, the tyre in  
25 accordance with the invention may ultimately involve a reinforcing edge 14 at an axially and/or radially external position to said annular reinforcing structures. More specifically, said reinforcing edge may comprise elongated reinforcing elements disposed  
30 inclined to the radial direction and preferably made up of a metallic cord having elementary filaments with a diameter included between 0.15 and 0.30 mm. Alternatively, use of textile cords is possible, said cords being made of Kevlar for example, other natural  
35 or synthetic fibres or glass fibre. Said edge 14 can

PT0276

- 24 -

have either two series of elongated elements, the elements of each series being axially superposed on, and crossed with those of the adjacent series, or a plurality of said elongated elements disposed in  
5 coplanar relationship and substantially parallel to each other.

Said elements can be directly disposed on the carcass structure or previously buried in a strip of elastomer  
10 material subsequently assembled with said carcass.

The tyre structure is finally completed with deposition of the belt structure 3, the sidewalls 5 and a tread band 4, then moulded and vulcanised.

15 It is to be noted that alternatively to the strip-like elements, a single continuous cord could be also used, which cord by appropriate laying in subsequent side by side arrangements on said toroidal support will make  
20 said carcass ply 2 with the same geometry. In this case therefore there will be no longer the presence, in the strict sense of the word, of a plurality of strip-like elements having terminal parts or ends, but a single cord having a plurality of stretches from bead to bead  
25 joined to each other, each junction being however substantially equivalent to each of said ends as above illustrated.

Therefore, in the present description and in the  
30 following claims, by the terminology "plurality of elongated elements" it is intended both a true multiplicity of strip-like elements physically distinct from each other, and a plurality of stretches belonging to the same cord, which substantially extend from bead  
35 to bead and are joined together.

PT0276

- 25 -

C L A I M S

1. A tyre for vehicle wheels comprising: a carcass structure including at least one carcass ply (2), said  
5 carcass structure having two side portions at positions spaced apart from each other in an axial direction, and a crown portion extending in a radially external position between said side portions, at least one  
10 carcass structure at said side portions, said annular reinforcing structure comprising at least one bead core (10, 11), one tread band (4) at a position radially external to said carcass structure, and a pair of sidewalls (5) at axially opposite positions on said  
15 carcass structure, each carcass ply (2) comprising a plurality of elongated elements disposed in a substantially U-shaped conformation around the cross-section profile of said tyre (1), wherein a fraction of the plurality of said elongated  
20 elements is turned up around said at least one bead core.

2. A tyre as claimed in claim 1, wherein said annular reinforcing structure comprises a first bead core (10)  
25 at an axially internal position and a second bead core (11, 13) at an axially external position relative to said carcass ply (2).

3. A tyre as claimed in claim 2, wherein said fraction  
30 of the plurality of elongated elements is turned up around said axially-external second bead core (11, 13).

4. A tyre as claimed in claim 2, wherein said fraction  
of the plurality of elongated elements is turned  
35 up around said axially-internal first bead core

PT0276

- 26 -

(10).

5. A tyre as claimed in claim 3 or 4, wherein the carcass ply stretch interposed between said first (10) and second (11, 13) bead cores has a cross-section profile of a length (c) included between 15 and 70 mm.

6. A tyre as claimed in claim 2, wherein said annular reinforcing structure comprises a third bead core (12) at an axially external position to said second bead core (11).

7. A tyre as claimed in claim 1, wherein said fraction of the plurality of elongated elements is substantially equal to or lower than 50% of the overall number of said elongated elements.

8. A tyre as claimed in claim 1, wherein the ends of said turned-up elongated elements lie in different planes.

9. A tyre as claimed in claim 1, wherein said tyre (1) has an edge (14) axially and/or radially external to each annular reinforcing structure.

10. A tyre as claimed in claim 1, wherein said elongated elements consist of strip-like elements (6, 6', 7, 7', 7").

11. A tyre as claimed in claim 10, wherein said strip-like elements (6, 6'; 7, 7', 7") are of at least two lengths ( $L_1$ ,  $L_2$ ;  $L_3$ ,  $L_4$ ) different from each other.

12. A tyre as claimed in claim 10, wherein said strip-like elements (7, 7') are of same length ( $L_3$ ).

PT0276

- 27 -

13. A method of manufacturing a tyre for vehicle wheels, said tyre (1) comprising a carcass structure including at least one carcass ply (2), at least one annular reinforcing structure associated with said carcass structure and comprising at least one bead ring (10, 11), one tread band (4) at a radially external position to said carcass structure, and a pair of sidewalls (5) at axially opposite positions on said carcass structure, wherein accomplishment of said carcass structure comprises the steps of:

- preparing a plurality of elongated elements coated with at least one layer of elastomer material;
- laying each elongated element onto a toroidal support in a substantially U-shaped conformation around the cross-section profile of said toroidal support to define two side portions spaced apart from each other in an axial direction, and a crown portion extending at a radially external position between said side portions;
- applying said at least one bead core (10, 11) at a region close to said side portions, at least one fraction of said elongated elements having an end at a radially more internal position than said at least one bead core (10, 11);
- turning up said ends of said fraction around said bead core.

14. A method as claimed in claim 13, wherein said turning-up step is preceded by a step of laying at least one axially internal first bead core (10) and one axially external second bead core (11, 13) relative to said carcass ply (2).

15. A method as claimed in claim 14, wherein said turning-up step is carried out subsequently to the step

PT0276

- 28 -

of laying a layer of reinforced polymeric material at an axially external position to said second bead core (11).

5 16. A method as claimed in claim 14, wherein said turning-up step is carried out around said axially-external second bead core (11, 13).

10 17. A method as claimed in claim 14, wherein said turning-up step is carried out around said axially-internal first bead core (10).

15 18. A method as claimed in claim 16, wherein said turning-up step is carried out in at least two sub-steps separated by a step of laying a filler in an axially external position to the axially external edge of said second bead core (11, 13), the elongated elements turned-up during the second sub-step lying in offset planes relative to the elongated elements turned  
20 up during the first sub-step.

19. A method as claimed in claim 16, wherein the turning-up step is followed by a step of laying a third bead core (12) at an axially external position to said  
25 second bead core (11).

20. A method as claimed in claim 13, wherein said elongated element consisting of a strip-like element (6, 6', 7, 7', 7'') is submitted, during said  
30 preparation step, to a cutting step starting from a continuous ribbon-like element.

21. A method as claimed in claim 20, wherein said cutting step prepares strip-like elements (7, 7') of  
35 the same lengths.

PT0276

- 29 -

22. A method as claimed in claim 20, wherein said cutting step prepares strip-like elements (6, 6'; 7, 7") of different lengths.

5 23. A method as claimed in claim 22, wherein said deposition step is carried out by laying strip-like elements (6, 6') of different length symmetrically with each other relative to the equatorial plane (X-X) of said toroidal support.

10

24. A method as claimed in claim 21, wherein said deposition step is carried out by laying strip like elements (7, 7') of the same length asymmetrically relative to the equatorial plane (X-X)

15 of said toroidal support.

25. A method as claimed in claim 24, wherein said step of laying strip-like elements (7, 7') of same length involves deposition of at least one strip-like element  
20 (7") of smaller length symmetrically relative to said equatorial plane (X-X).

26. A method as claimed in claim 20, wherein said strip-like element (6, 6', 7, 7', 7") during said  
25 preparation step is submitted to a necking-down step.

27. A method as claimed in claim 13, wherein said annular reinforcing structure comprises at least one bead core (10, 11, 12) obtained by a step of winding a  
30 plurality of coils of metal wire disposed in radial superposition and axial side by side relationship with each other.

28. A method as claimed in claim 13, wherein a step of  
35 laying an edge (14) at an axially and/or radially

PT0276

- 30 -

external position to said annular reinforcing structure  
is provided.

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PT0276

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FIG 1

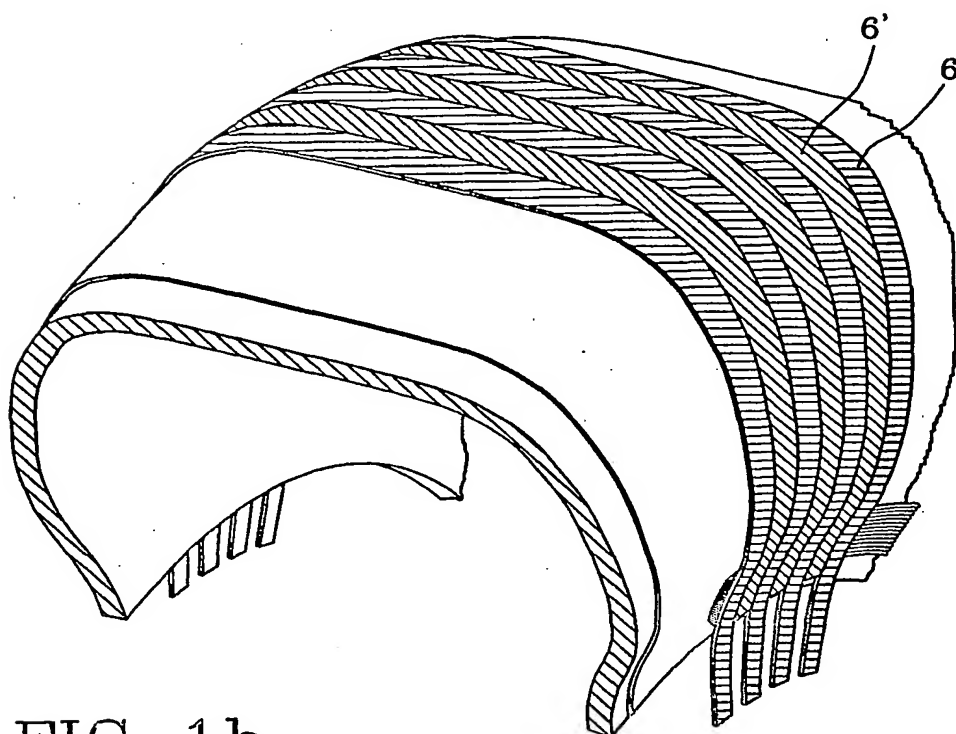
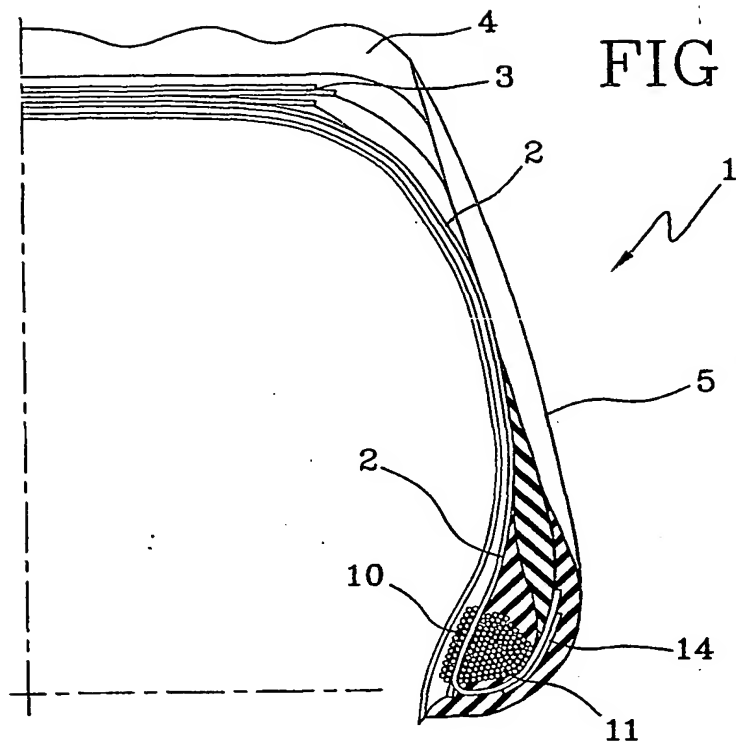


FIG 1b

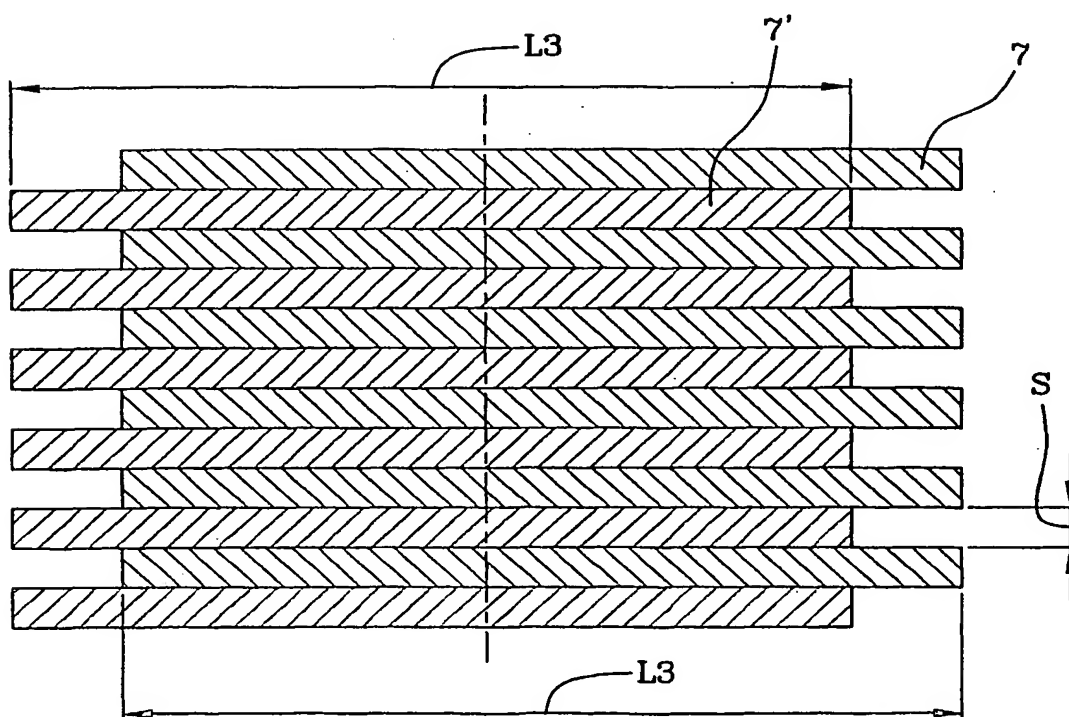
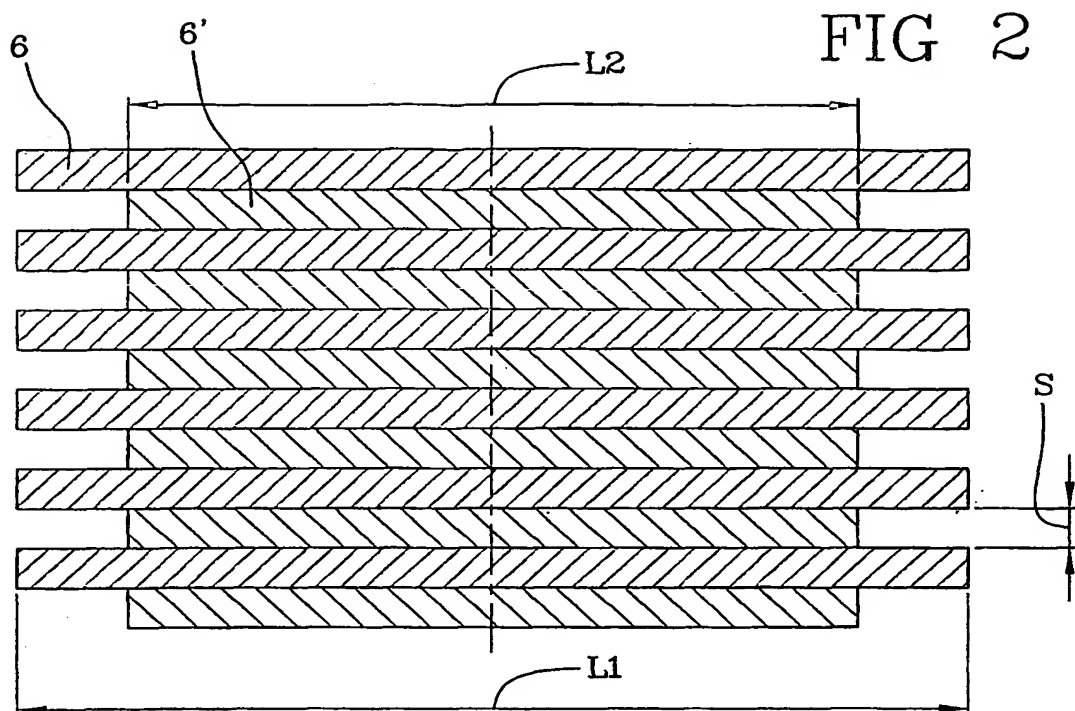


FIG 3

FIG 4a

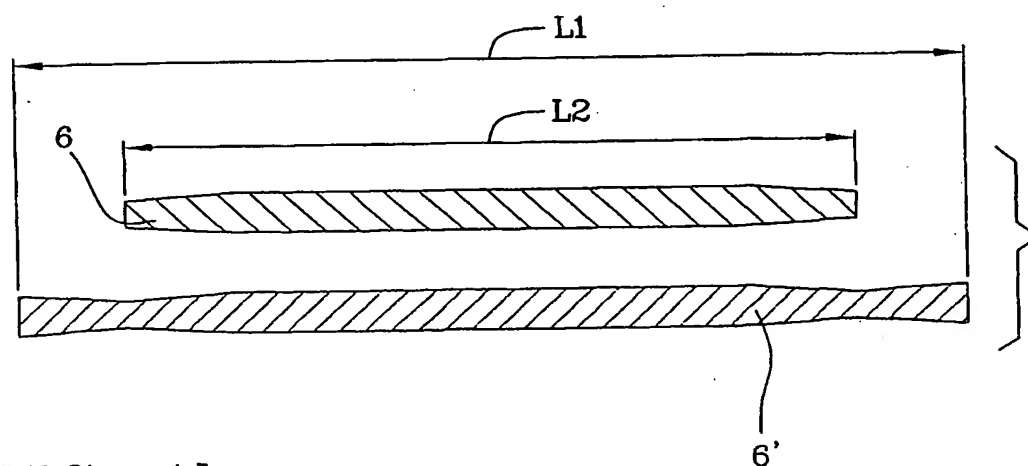
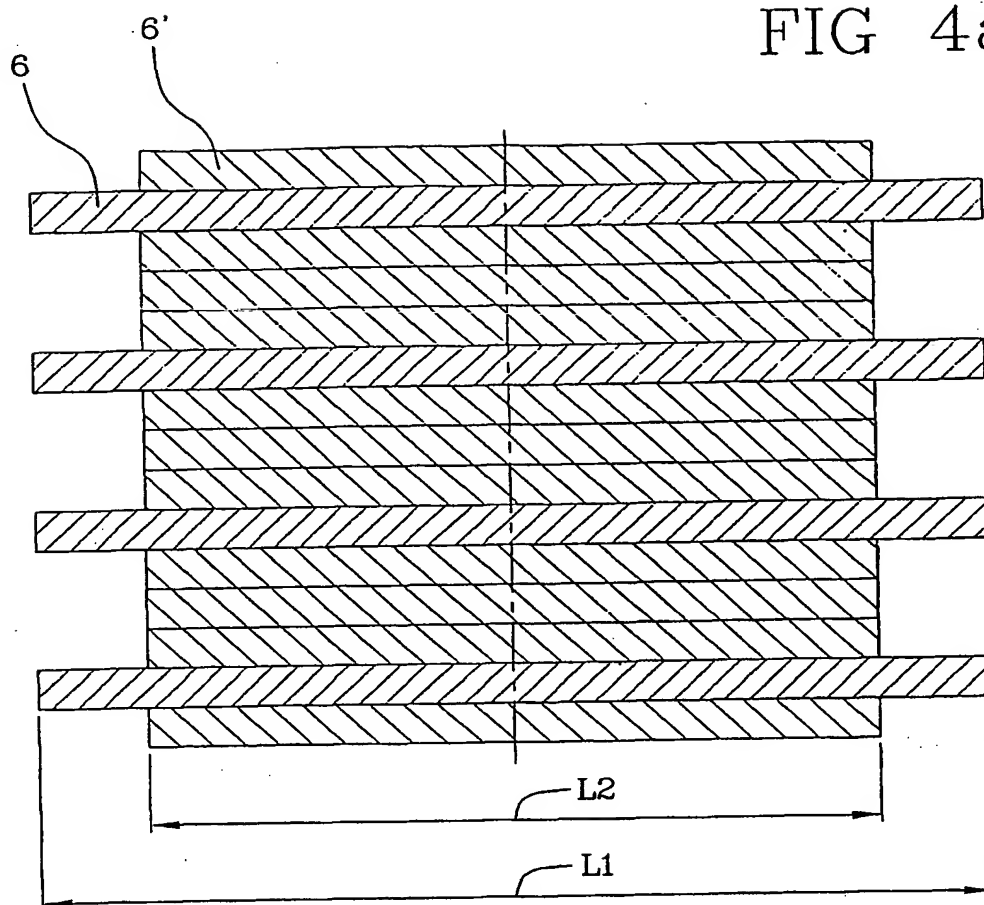


FIG 4b

FIG 5a

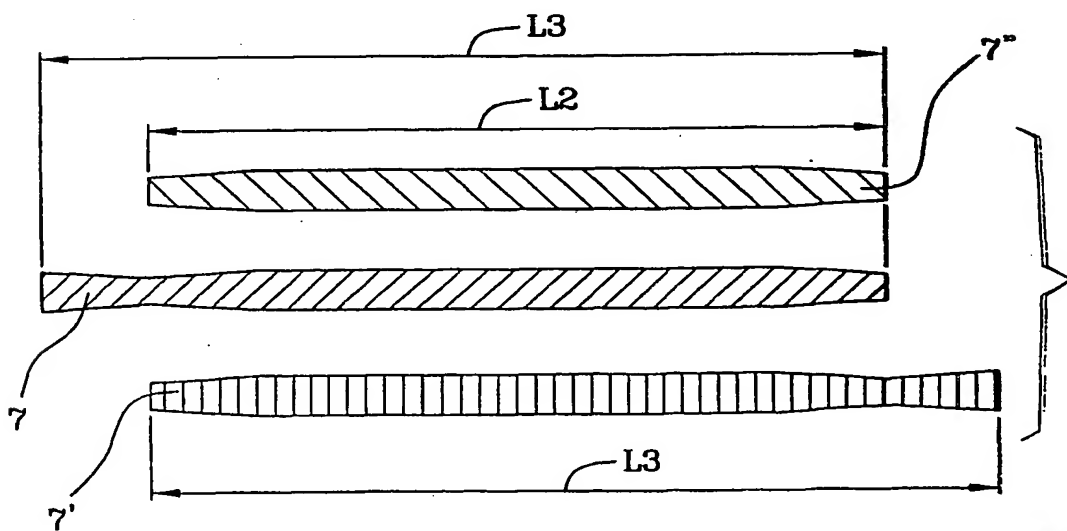
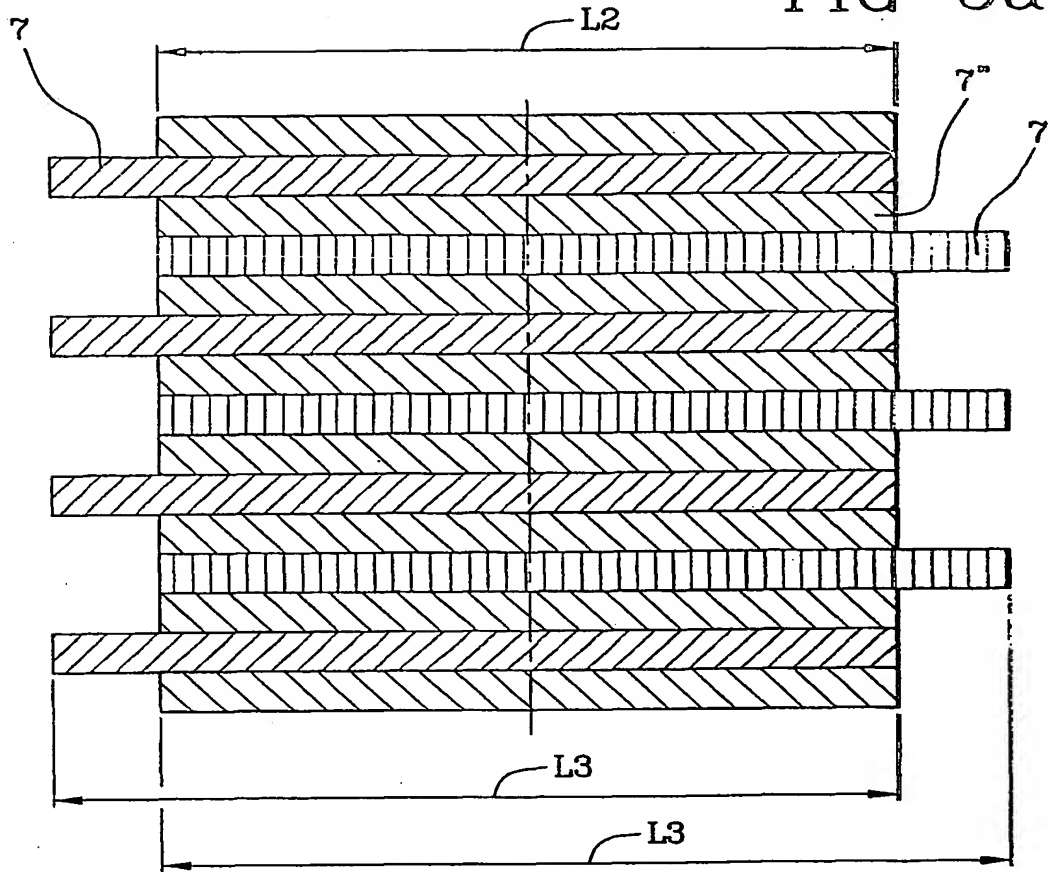


FIG 5b

FIG 6

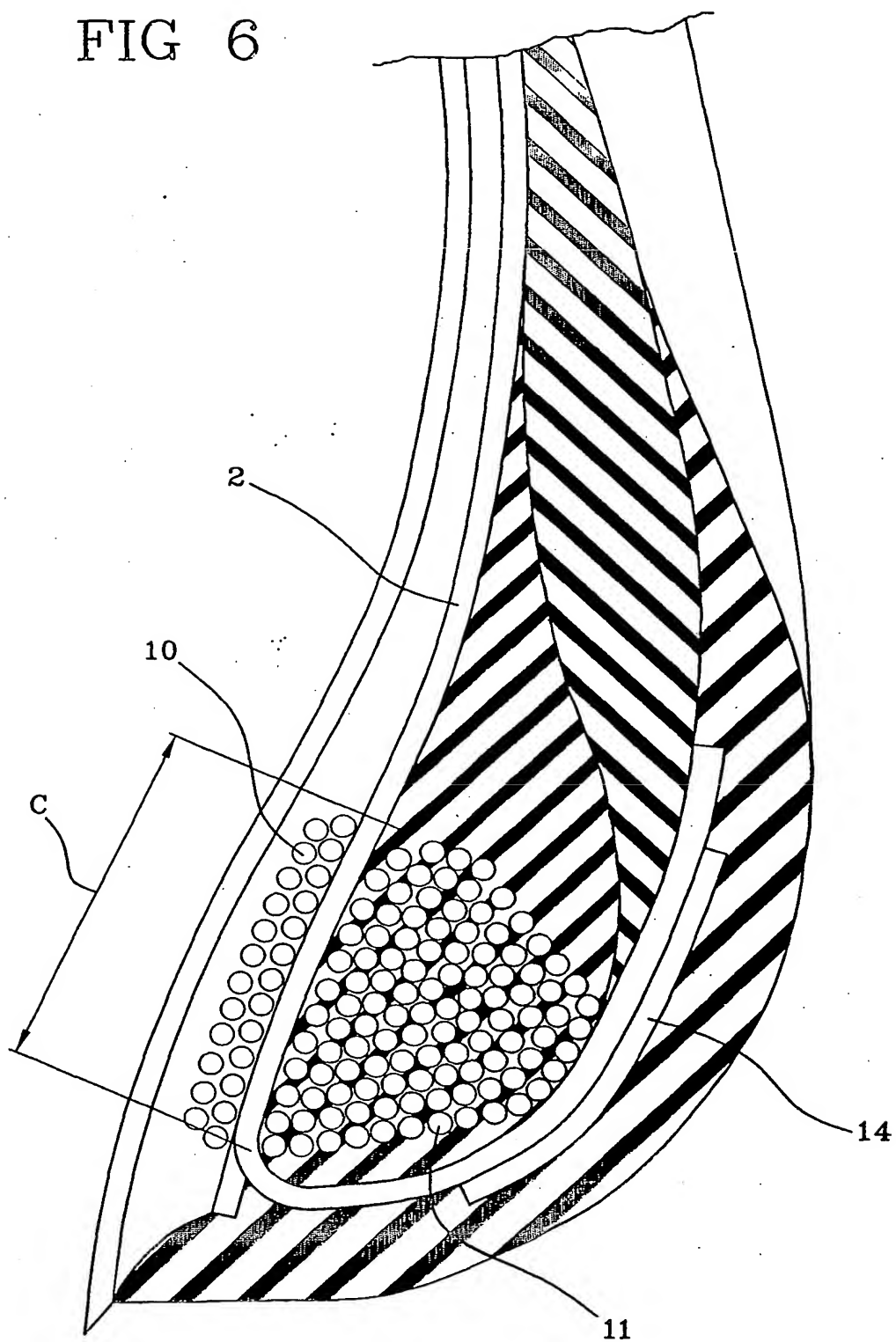


FIG 8

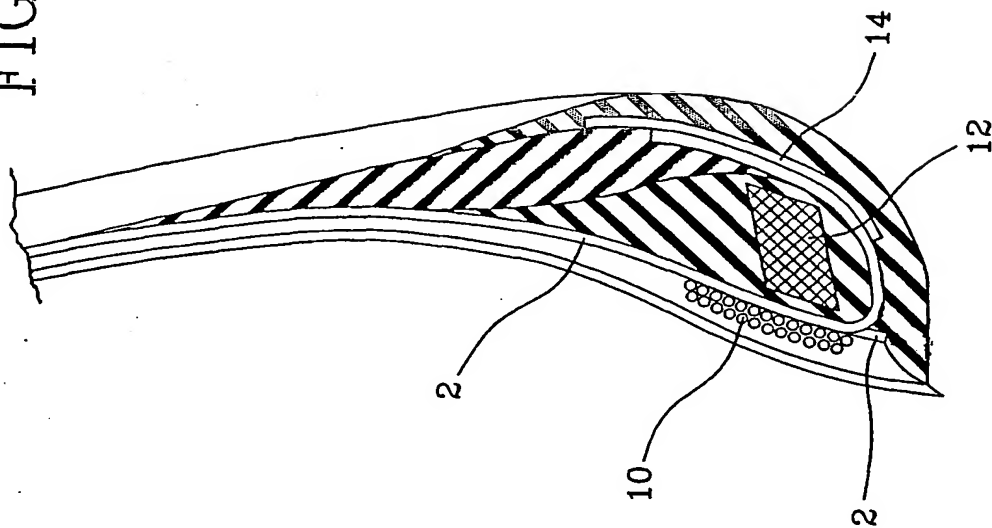


FIG 7

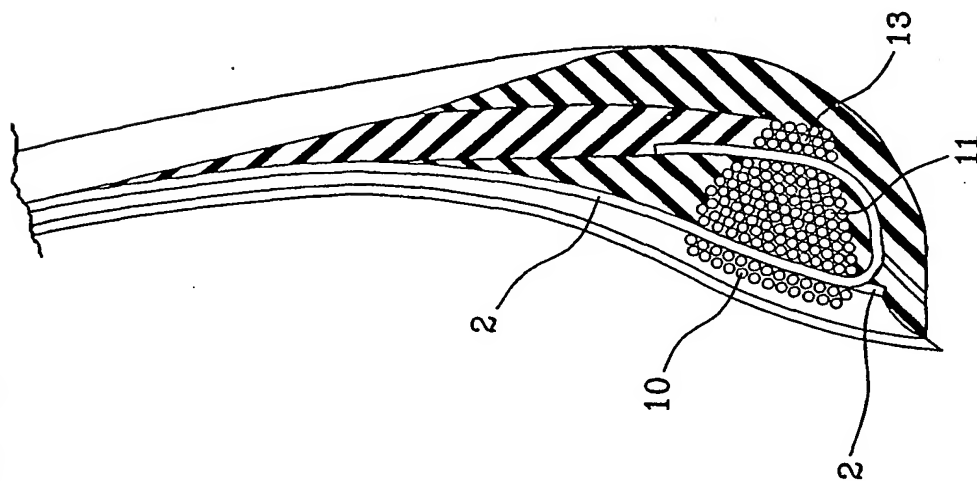
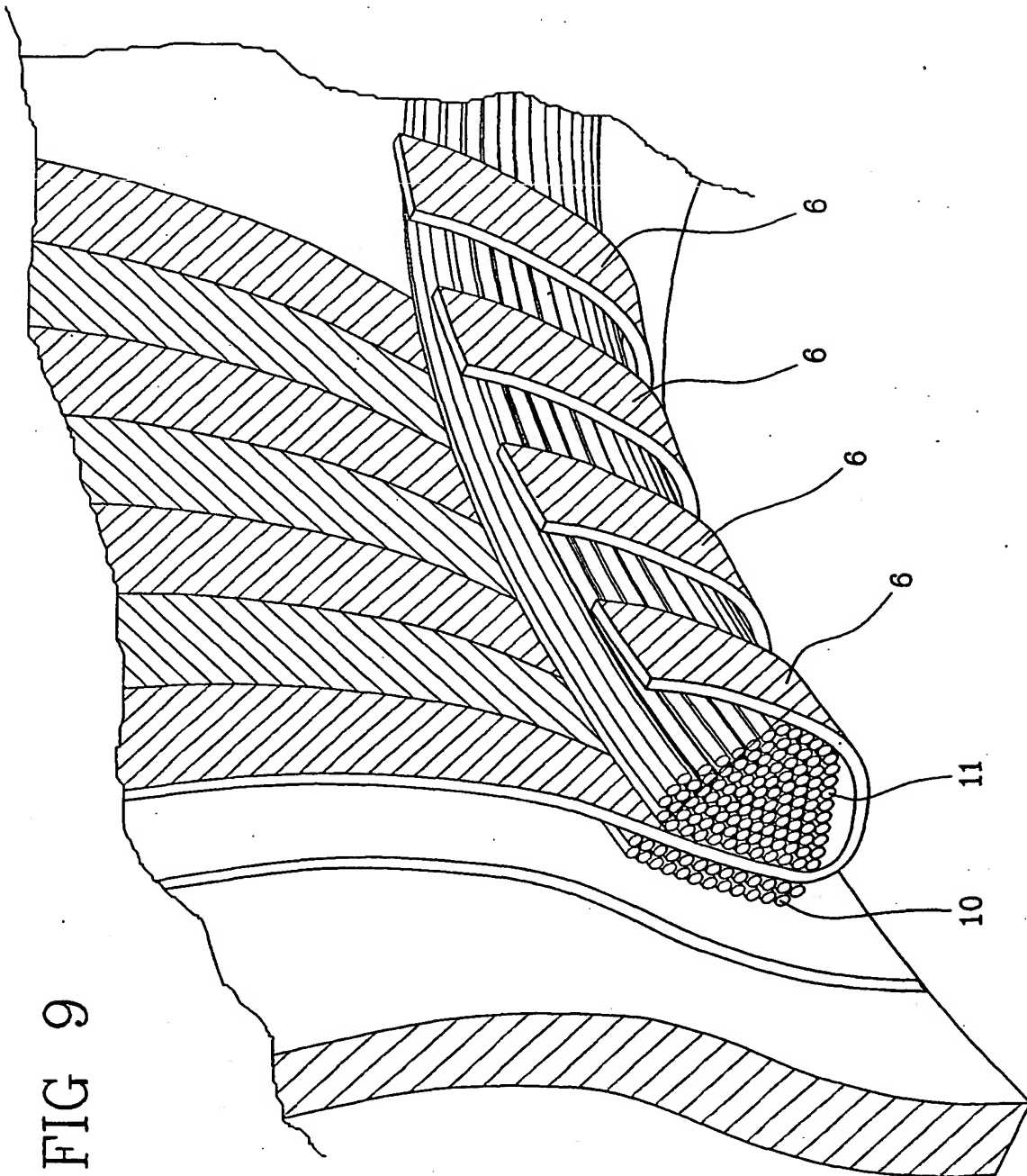


FIG 9



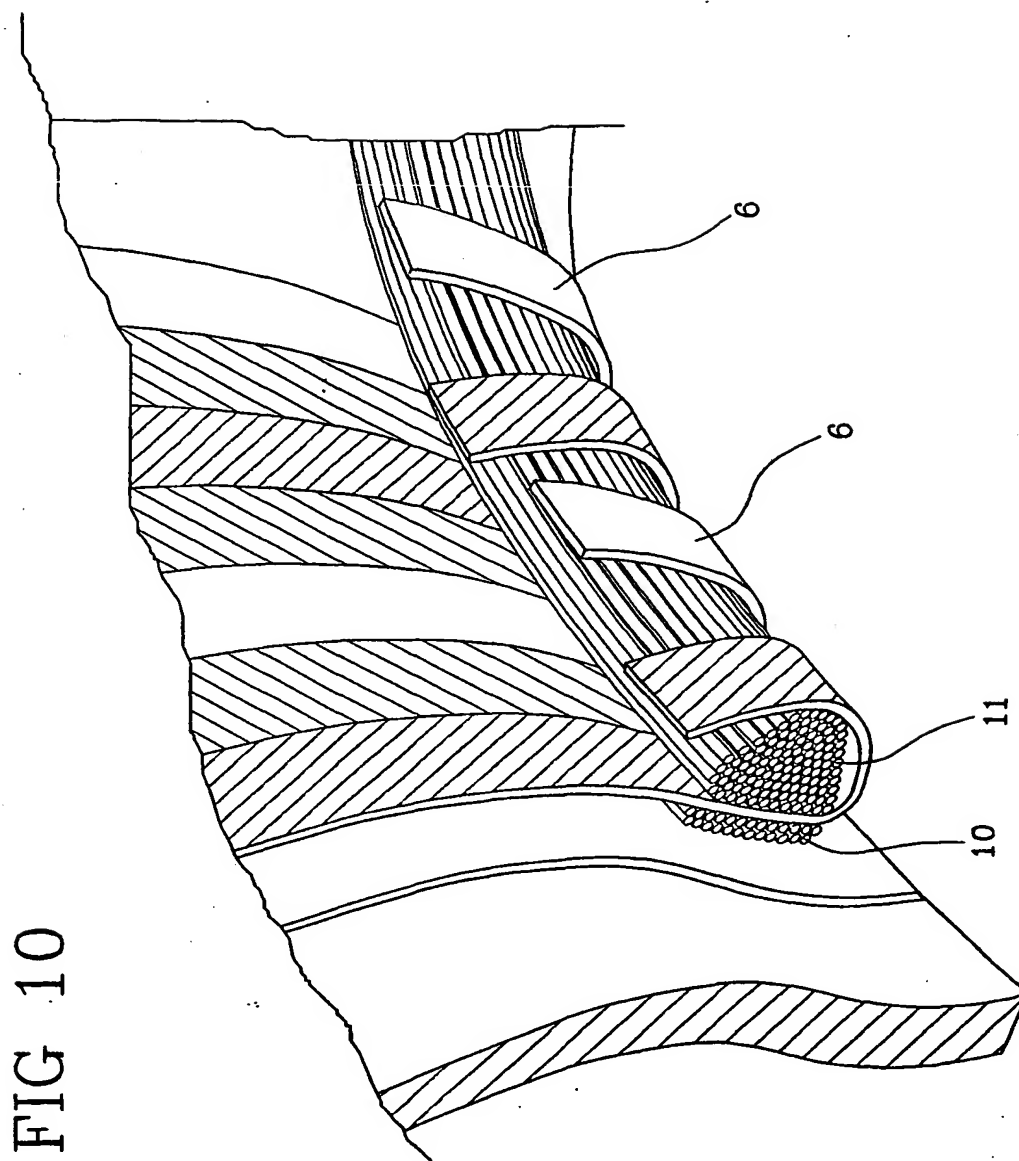


FIG 10

FIG 11

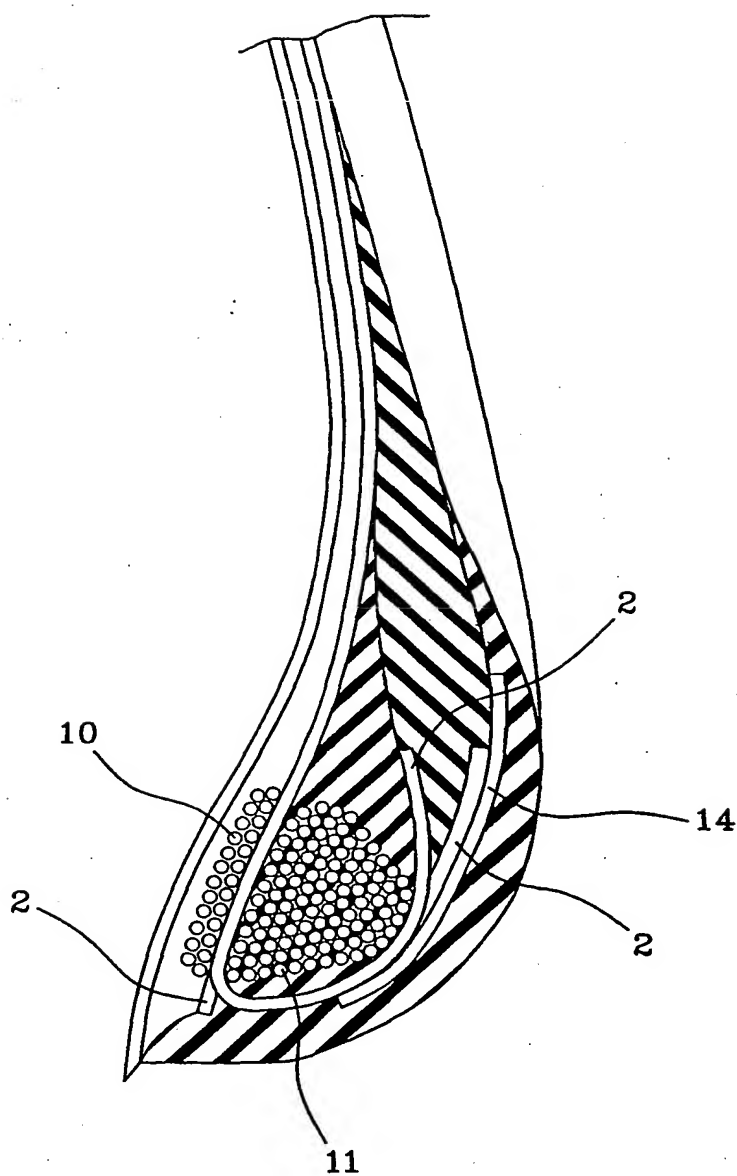
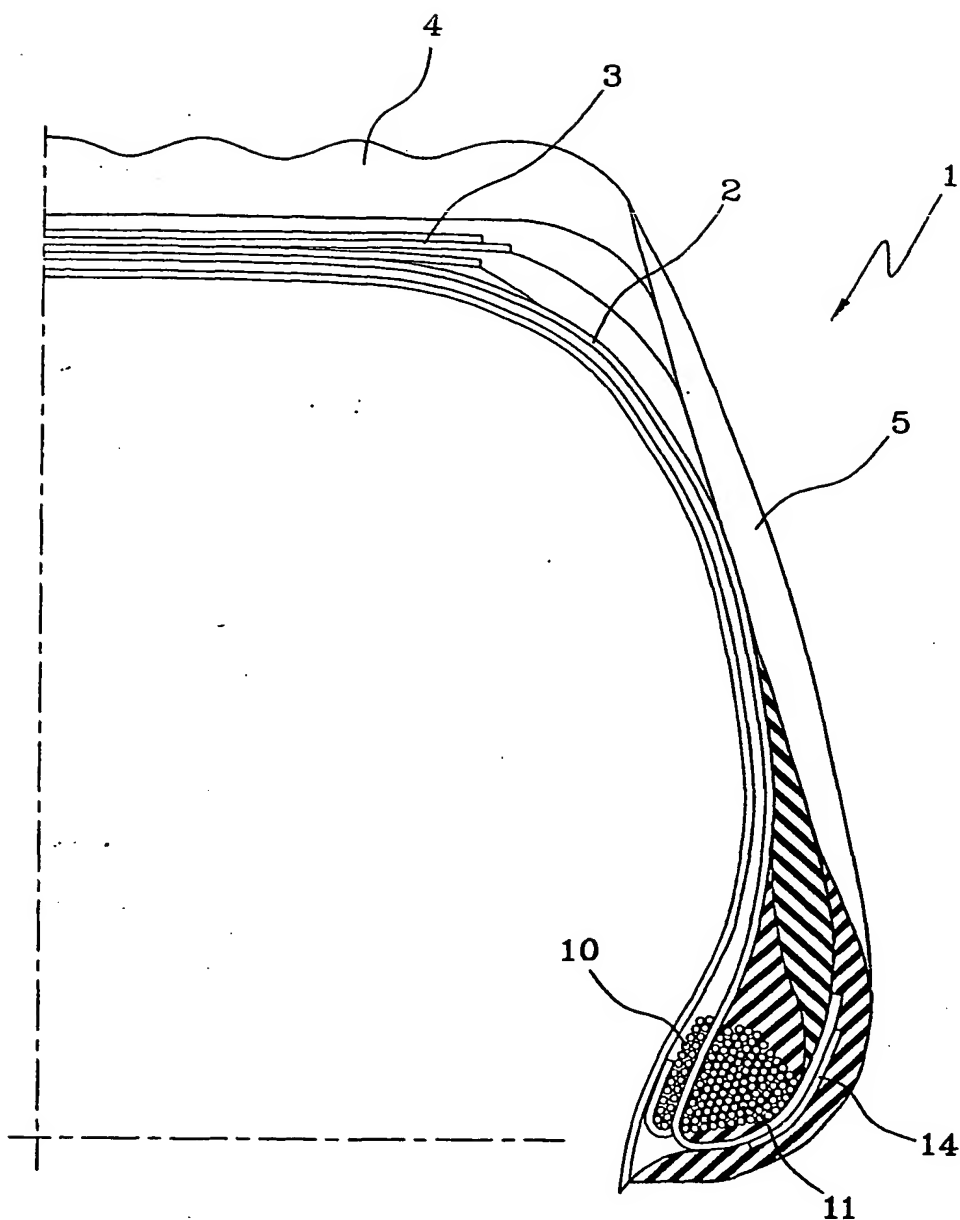


FIG 12



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 03/01473

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B60C15/00 B60C9/02 B29D30/10 B60C15/05

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B60C B29D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 383 992 A (SIEGENTHALER KARL J) 24 January 1995 (1995-01-24)	1
A	claims; figures 1,2 ---	13
X	WO 00 26043 A (PIRELLI ; CARETTA RENATO (IT)) 11 May 2000 (2000-05-11) claim 1; figures ---	13
A	EP 0 983 876 A (BRIDGESTONE CORP) 8 March 2000 (2000-03-08) cited in the application claims; figures ---	1,2,13
A	EP 0 928 702 A (PIRELLI) 14 July 1999 (1999-07-14) cited in the application claims; figures ---	13
	--- -/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

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Date of the actual completion of the international search

26 November 2003

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 03/01473

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 3 815 652 A (POUILLoux J)  11 June 1974 (1974-06-11)  -----</p>	

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IB 03/01473

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5383992	A	24-01-1995	IT	1250560 B	20-04-1995
WO 0026043	A	11-05-2000	AT	233184 T	15-03-2003
			DE	69905600 D1	03-04-2003
			WO	0026043 A1	11-05-2000
			EP	1124699 A1	22-08-2001
			US	2002124935 A1	12-09-2002
EP 0983876	A	08-03-2000	JP	2000071722 A	07-03-2000
			EP	0983876 A2	08-03-2000
EP 0928702	A	14-07-1999	EP	0928702 A1	14-07-1999
			AT	250517 T	15-10-2003
			BR	9805744 A	14-12-1999
			DE	69725154 D1	30-10-2003
			JP	11254906 A	21-09-1999
			TR	9802758 A1	21-07-1999
			TW	418165 B	11-01-2001
			US	6328084 B1	11-12-2001
			US	2002056498 A1	16-05-2002
US 3815652	A	11-06-1974	FR	2132509 A5	24-11-1972
			AT	324859 B	25-09-1975
			AU	462433 B2	09-06-1975
			AU	4078272 A	11-10-1973
			BE	781694 A1	05-10-1972
			CA	957255 A1	05-11-1974
			DD	98865 A5	12-07-1973
			DE	2214553 A1	12-10-1972
			ES	401438 A1	01-10-1975
			GB	1392002 A	23-04-1975
			IT	954598 B	15-09-1973
			LU	65104 A1	07-12-1972
			NL	7204449 A	09-10-1972
			SE	381427 B	08-12-1975
			YU	86072 A	31-12-1976